along the ridges and bluffs. Danthonia compressa, distinguished by its greener color, much longer and more abundant leaves, taller culms, more elongated panicles and especially by the longer teeth to the flowering glumes, was the most abundant species of all and the chief component of the luxuriant and dense turf covering the extensive meadows of the treeless areas on the mountain top. The abundance of this grass and the excellent condition of the cattle grazing on it clearly showed its importance as a forage plant. It is a species found along the mountains from the Carolinas and Tennessee to New England, and wherever it grows abundantly yields excellent fodder for horses and cattle. A cool climate and abundant atmospheric humidity are apparently essential to its best growth.

Another species of Danthonia, viz., Danthonia Californica, especially the variety unispicata, occupies a similar position with respect to its abundance and value for forage, in the mountain meadows or "deer parks" of the Rocky Mountains in Montana.

The principal native fodder grasses of the high mountain meadows, or as they are familiarly termed in the west, "deer parks," are:

For the Alleghanies:
Danthonia compressa Austin.
For the Rocky Mountains in Montana:
Danthonia Californica var. *unispicata* Thurb.
Danthonia intermedia Vasey.
Festuca scabrella Torr.
Alopecurus occidentalis Scribn.
For the mountains of Arizona:
Poa Californica Vasey.
Muhlenbergia virescens Trin.
Muhlenbergia gracilis Trin.

Knoxville, Tenn.

Pickerel weed pollen.[1]

BYRON D. HALSTED.

The flowers of the pickerel weed (*Pontederia cordata* L.) are strictly trimorphic, as was determined by Mr. W. H. Leggett in 1875. There are six stamens in each blossom, placed in two sets of three each, and a single style. The

[1]Read before the Botanical Club of the A. A. A. S., at the Toronto meeting, 1889

shortest set of stamens is near the base of the corolla tube, and the anthers are not in the same plane, a condition due perhaps to the confined space. A similar variation is, however, found in the other sets of stamens without the same apparent reason. The anthers of all three sets are practically of the same size and color, and might be easily mistaken for each other when the filaments are removed. As in all truly trimorphic flowers, there are six possible kinds of pollen and eighteen combinations of pollen with the stigmas. There is a remarkable range in sizes of pollen, but only three prevailing dimensions, as the following table shows in micro-millimeters:

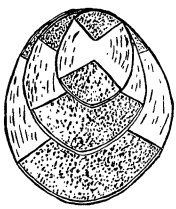
		Dry.		Wet.
Long stamens:	Short style,	22.4 × 57.6	—	44.8 × 54.4.
	Mid style,	25.9 × 51.2	—	44.8 × 57.6.
Mid stamens:	Short style,	19.2 × 42.6	—	32. × 41.6.
	Long style,	25.6 × 51.2	—	35.2 × 44.8.
Short stamens:	Mid style,	12.8 × 28.8	—	25.6 × 28.8.
	Long style,	12.8 × 28.8	—	25.6 × 28.8.

By averaging each set, we have:

	Dry.		Wet.
Long stamens,	24.1 × 54.4	—	44.8 × 56.
Mid stamens,	22.4 × 46.9	—	33.6 × 43.2.
Short stamens,	12.8 × 28.8	—	25.6 × 28.8.

The measurements of the dry and wet pollen indicate a great change in size and shape when water is added to the dusty pollen as it comes from the dehisced anthers. When dry it has two sutures in the outer coat and resembles a wheat grain in general appearance, but upon the application of water the inner wall enlarges, expands between the two slits in the outer wall, and the grain becomes elliptical or nearly spherical.

Referring to the table of averages it will be seen that the measurements for the short stamen pollen are about half of those for the grains from the longest stamens, and if the size of the smallest pollen, when wet, is represented by $3 \times 3\frac{1}{2}$ inches those of the largest will be 6×7 and the corresponding relative size of the mid stamen pollen is $4\frac{1}{2} \times 5\frac{1}{4}$, or a half of the sum of the figures for the extreme forms.



Three sizes of moist Pontederia pollen.

By glancing at the relative sizes of pollen in other trimorphic plants, as recorded by Darwin and others, it is found for—

Lythrum Salicaria, as 10 — 7 — 6, or 100 to 60.
Nesæa verticillata, " 13 — $9\frac{1}{2}$ — $8\frac{1}{2}$, " 100 " 65.
Oxalis speciosa, " 16 —13 —11, " 100 " 69.
Oxalis Validiviana, " $8\frac{1}{2}$ — 7 — 6, " 100 " 71.
Oxalis Rignelli, " 9 — $8\frac{1}{2}$ — 7, " 100 " 78.

In a trimorphic Pontederia discovered by Fritz Müller in Brazil, the relative sizes of pollen as determined by Darwin[2] are 16—13—9, or 100 to 55. Our own species, therefore, by reducing to the same terms, is as 100 to 54, which accords to Pontederia cordata the greatest range for pollen that has yet been found in any flower.

The variation of pollen among dimorphic flowers does not approach this, as the following short table of the most striking illustrations shows:

Forsythia suspensa	as 100 to 94.
Pulmonaria angustifolia	" 100 " 91.
Polygonum Fagopyrum	" 100 " 82.
Pulmonaria officinalis	" 100 " 78.
Phlox subulata	" 100 " 75.
Primula vulgaris	" 100 " 71.
Primula veris	" 100 " 67.

When the contents of the pollen grains are taken into consideration it is seen that those of the largest stamens of Pontederia cordata are to those of the smallest as 8 to 1. Mr. Leggett[3] was aware of this remarkable difference at the time of his study of the flowers, but he was in doubt as to the smaller being perfect. To throw some light upon this point six small wells in an artist's slab were filled with sugar solution, and into two of them the largest pollen was placed—one lot from flowers with mid styles and the other from a short-styled form. A corresponding set was made for each of the other sizes of pollen. The largest grains germinated with the greatest promptness and vigor, and the tubes were naturally much broader and in every way larger than with the smallest sized grains, which as above stated contained only one-eighth as much of substance. There was no observed difference in pollen of the same set of stamens from flowers with different lengths of styles, and all sizes were equally able to germinate when sufficient time was given. The largest pollen tubes need to penetrate a style nearly an inch in length, while the short styles are exceedingly short. As far as I know it is invariably true with both dimorphic and trimorphic plants that the longest grains are borne by the longest stamens, and designed for the longest styles. Therefore, other things remaining constant, the length of style may be an index of the size of the pollen.

New Brunswick, N. J.

[2] Different forms of flowers on same species, p. 186.

[3] Torrey Bulletin, Nov. 1875.